Echo Commissioning and Beyond

2004 AMSAT-NA Space Symposium

October 8-10, 2004

Arlington, Virginia

Mike Kingery – KE4AZN

Jim White – WD0E

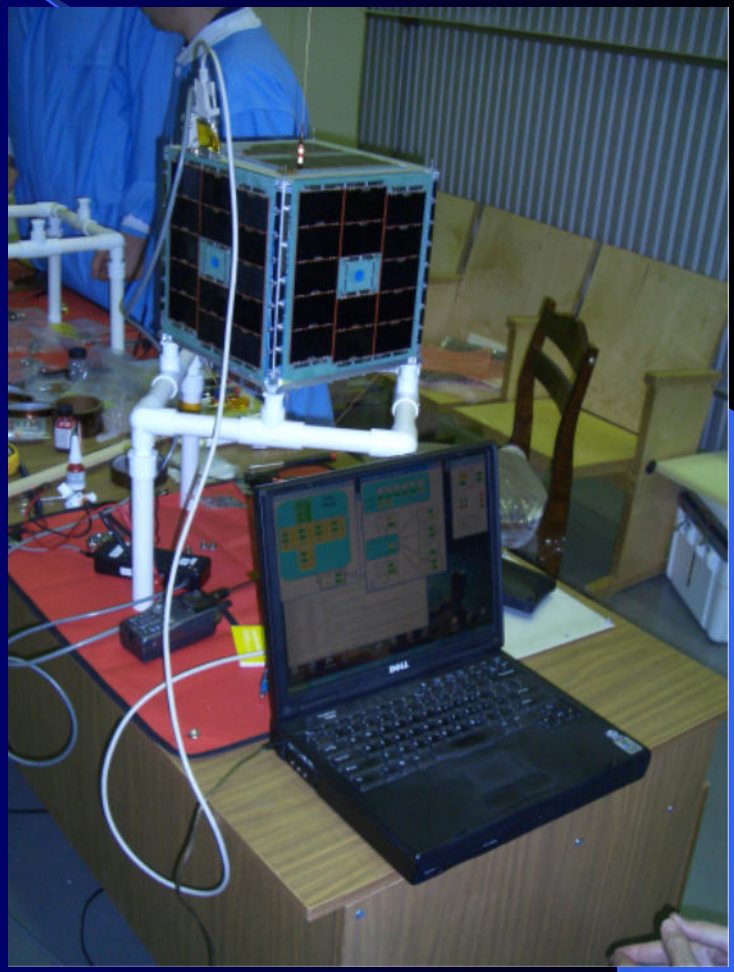
Echo Command Team

Launch Day

June 29, 2004

2:30 AM CST Wake Up Call at KE4AZN
Jim (WD0E) said "Echo launched successfully"

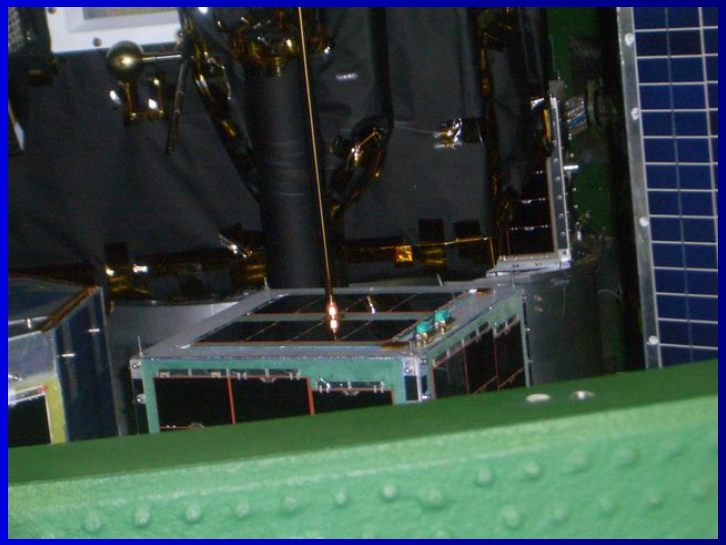
Initial Plans – First Pass over NA
- Beacon Echo and look for Response
- Load Kernal and PHTH from ROM
- Grab Telemetry for Satellite Initial Health Check



Picture Courtesy of Chuck Green, N0ADI

Launch Concerns

- Exact Frequency of TXA after launch
- Orbit Insertion Point, Time of Insertion
- Initial Satellite Health, Power System

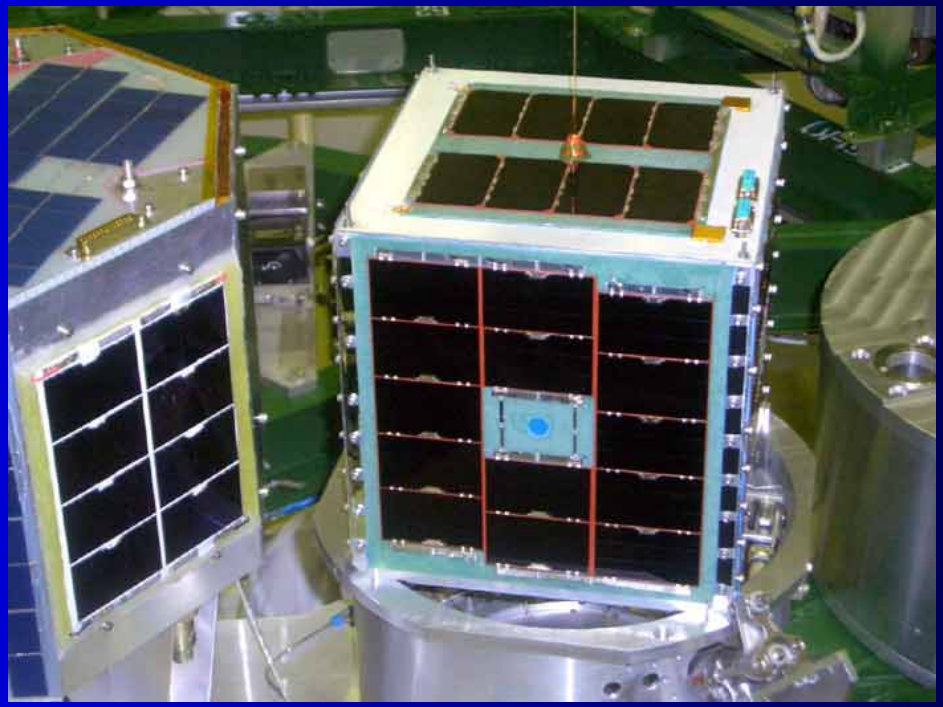


Pictures Courtesy of Chuck Green, N0ADI

Echo “First Contact”

At 14:52 UTC on 29 June 2004

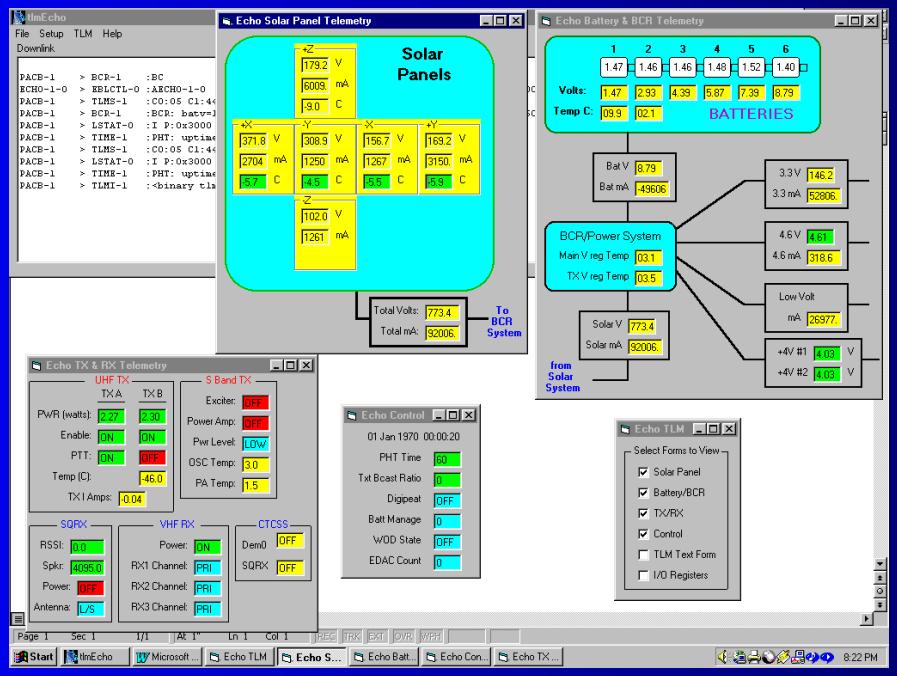
- KE4AZN sent the first commands to Echo
- Echo responded with a short TX burst on 435.150 mhz



Picture Courtesy of
Chuck Green,
N0ADI

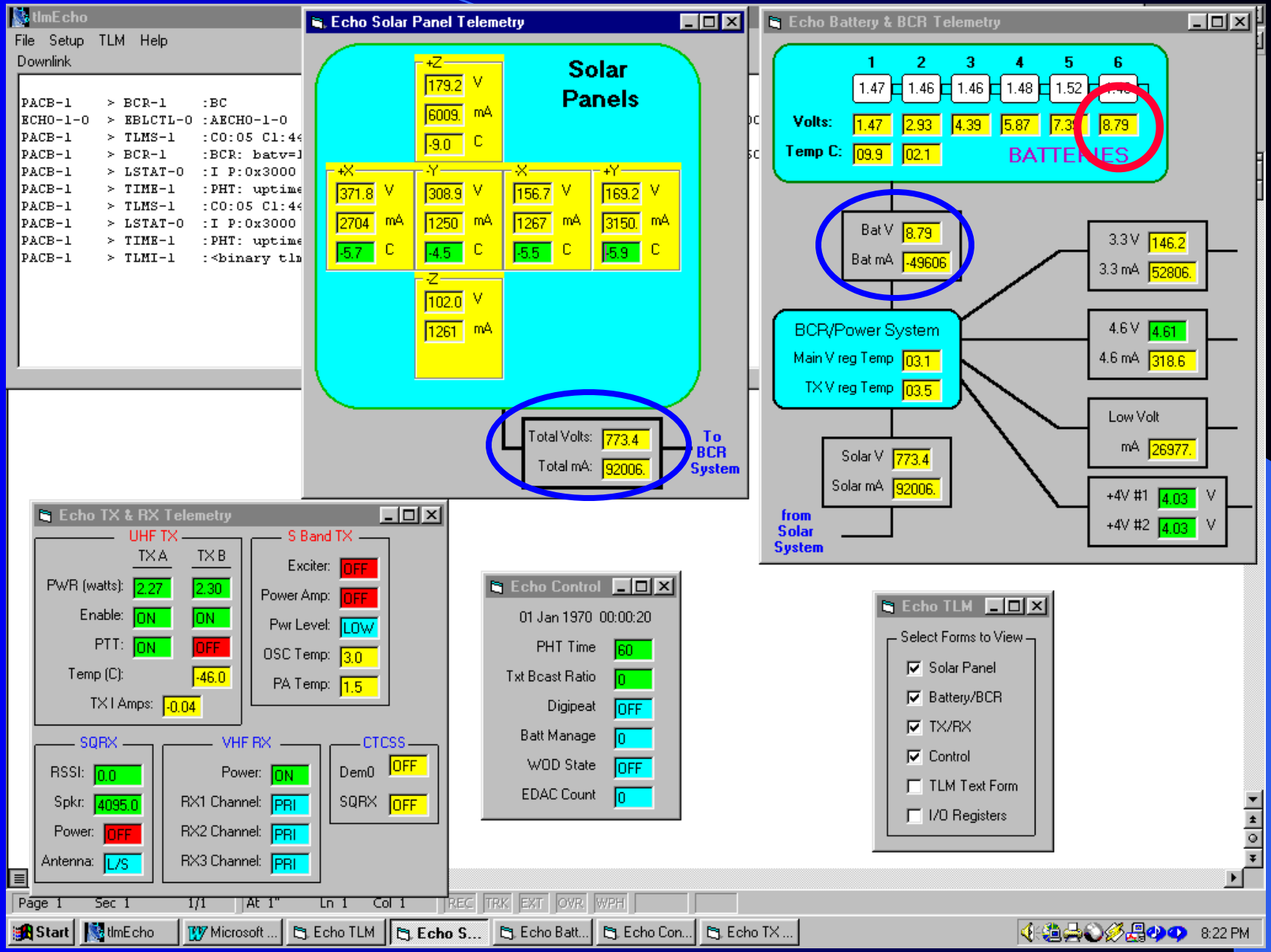
Echo First Telemetry View

- After successful Beacon Request responses by Echo
- Loaded the Kernal and PHTH from Echo's ROM
- TXA turned on for first time with Command Software
- First View of Echo's Telemetry



TlmEcho Screenshot by KE4AZN of Echo's first Digital Transmission

Telemetry Screen Shot from TlmEcho



Software Loading, Echo Day 1

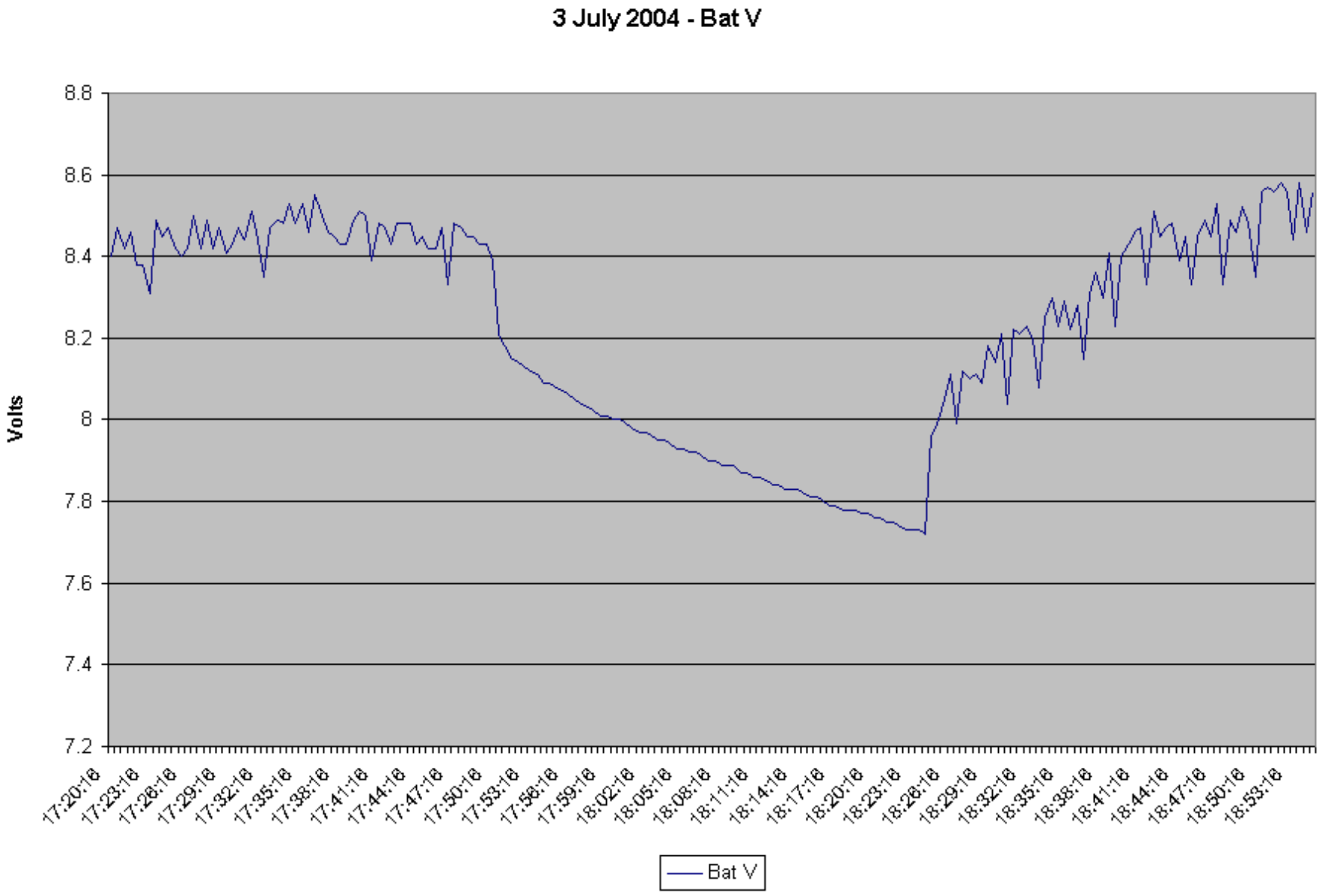
- First Load of QAX25 and PHTX
  - Completed QAX and most of PHTX on Pass 2
  - On Start of PHTX the Satellite Software Crashed
- Manually Reset Echo and loaded QAX and PHTX
- Loaded the File System
  - Loaded the incorrect version of Mfile
- Manually Reset Echo and started over

Echo Commissioning

- Completed the Software load through the File System
- Set the BCR Solar Panel Setpoint for Max Panel Power
- Tested the WOD collection system
- Collected WOD

  WOD allows us to watch Echo over long periods of time
- Collect One Orbit fast sample rate WOD for Attitude Check
- Pause to Collect WOD Data and Analyze

First WOD of Battery Voltage



Echo Commissioning

- Loaded RX Control Program (Task)

  Controls the SQRX Wide Band Receiver
- Powered up the SQRX Receiver

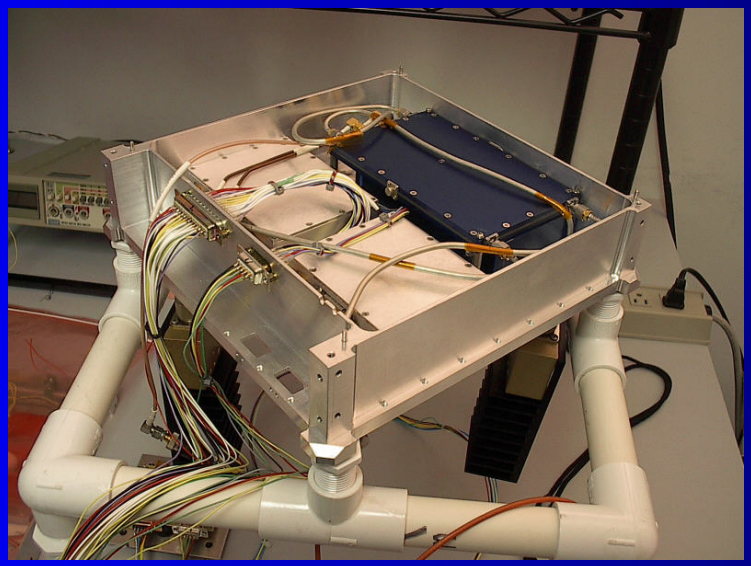
  Concerned about the SQRX based on Launch Site Tests
- Sent Commands (digital) through SQRX successfully
- Setup SQRX in FM Repeat mode

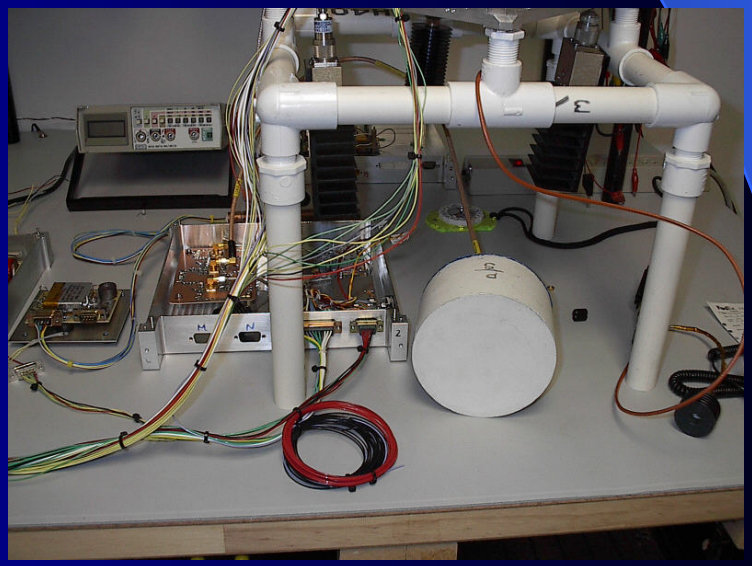
  Communicated FM Voice through Echo for the first time
- SQRX was working fine, BIG sigh of relief
- First Voice Transmission was via the SQRX, 7 July 2004

Echo Commissioning

- Reloaded PHTX Modified by Jim

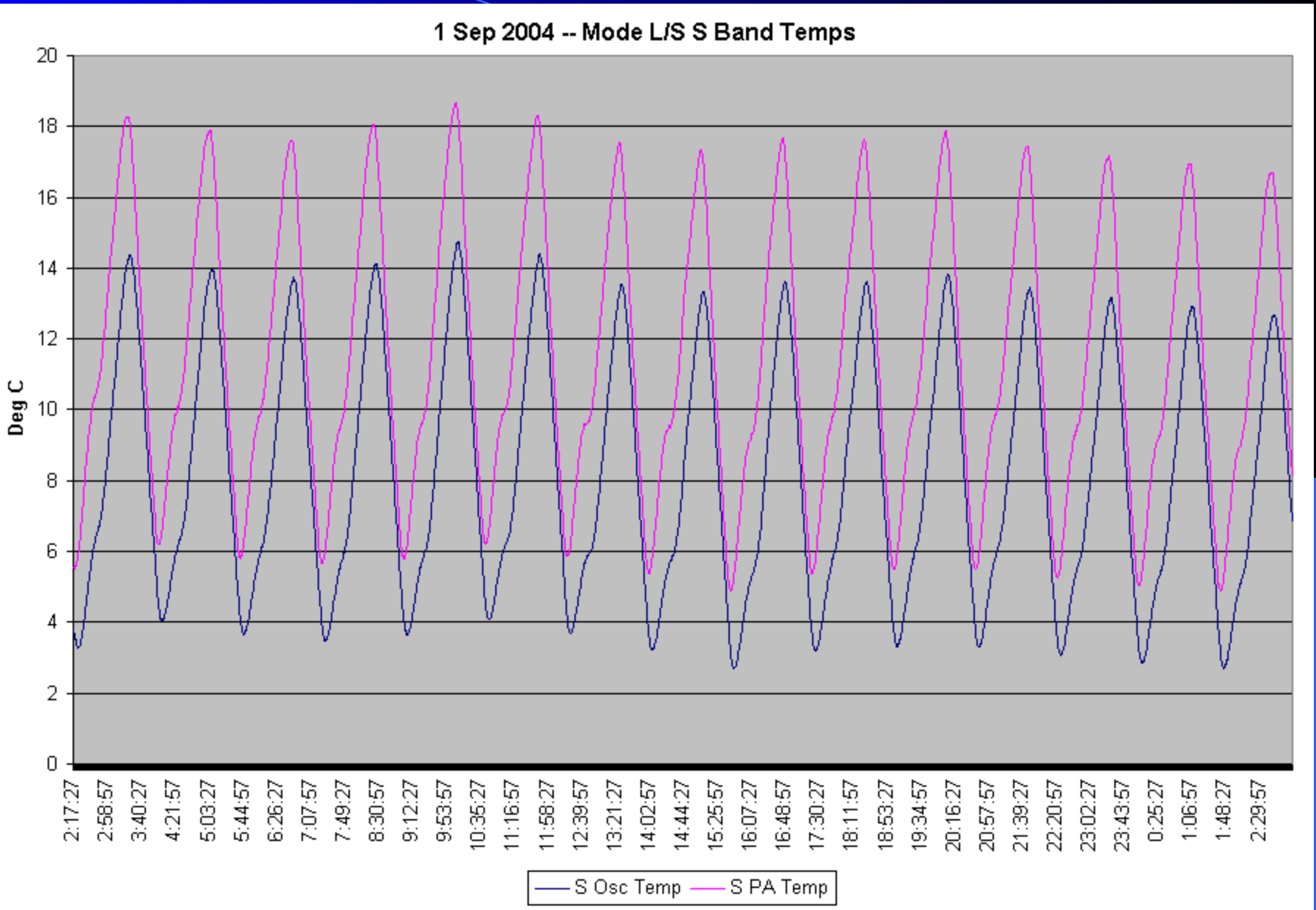
  Possible to reload and start PHTX without loading the entire satellite again
- Tested the 38k4 Digital Downlink on UHF
- Test S Band Transmitter





Pictures by Mike Kingery, KE4AZN

S Band TX Data



Echo Commissioning

- Test FM Repeater Mode
  - Worked with multiple settings to find the correct setup
  - Required both Command Stations, one commands, one talks
- Loaded the PL Control Code
  - Echo Software Crashed
- Reloaded the Entire Satellite Software
  - Modifications to Satellite Software made
  - Chance to test and improve the ground command station

Echo Commissioning

- Loaded and Executed the PL Control Program
  - Tested on Development IFC board
  - Never tested on Echo
- Tested and learned how to use the PL Code with Echo
  - Learned how the IFC works with the pieces of PL
  - Found improvements in the functionality of the PL code

Echo Commissioning

- Tested the 3 dedicated VHF Receivers on Pri Frequency
- Rechecked the PL control settings
- Collected WOD at various power levels of TXA and TXB
  Used to determine what power levels can be sustained
- Command Team ready for a break
- Ready to give the Amateur World the opportunity to
  Experience Echo for the first time

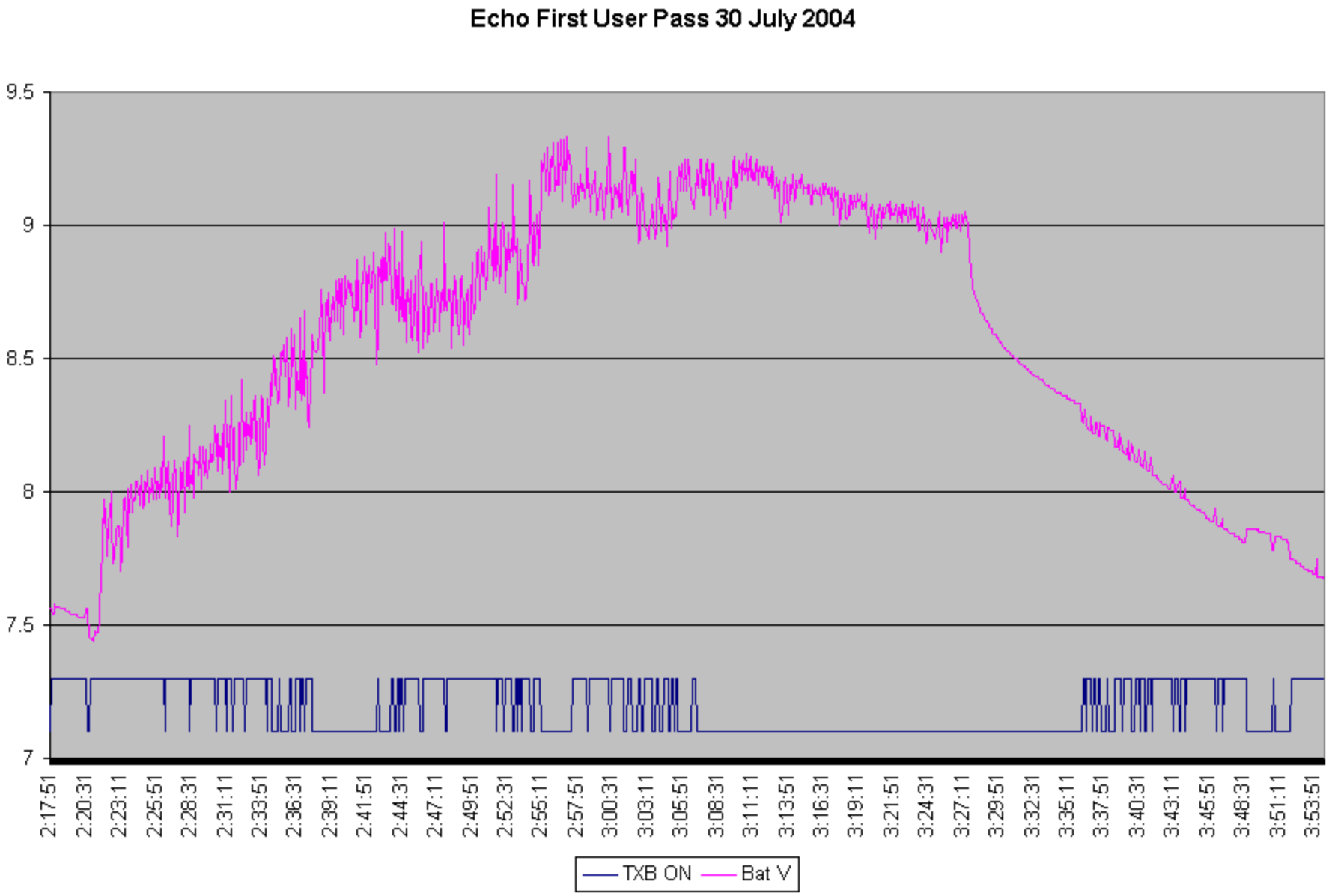
Echo Open to Users

- Enabled for Users 30 July 2004 at approximately 0216 utc
- Many Users on the first, and subsequent passes

  Learn about using PL mode

  Both Command Stations and Users

First User Pass WOD



Echo Satellite On-Board Software

- Boot Loader, Bob Diersing N5AHD
  - Operates Echo immediately after Separation
  - Takes over Control after a Software Crash
- SCOS Kernal, Harold Price NK6K
  - Operating System for Satellite
- Housekeeping Tasks (PHTH and PHTX), Jim White WD0E
  - Controls Satellite Functions
- File System, Harold Price NK6K
  - File Storage System, BBS System
- SQRX Control, Jim White WD0E
- PL Control, Jim White WD0E

Echo Ground Software

- Command and Control
  - GroundStation, Skip Hansen WB6YMH
  - Scloadh, Harold Price NK6K
  - ComEcho by Jim White WD0E and Mike Kingery KE4AZN
- Telemetry and Data
  - TlmEcho by Mike Kingery KE4AZN and Jim White WD0E
  - WodEcho by Mike Kingery KE4AZN

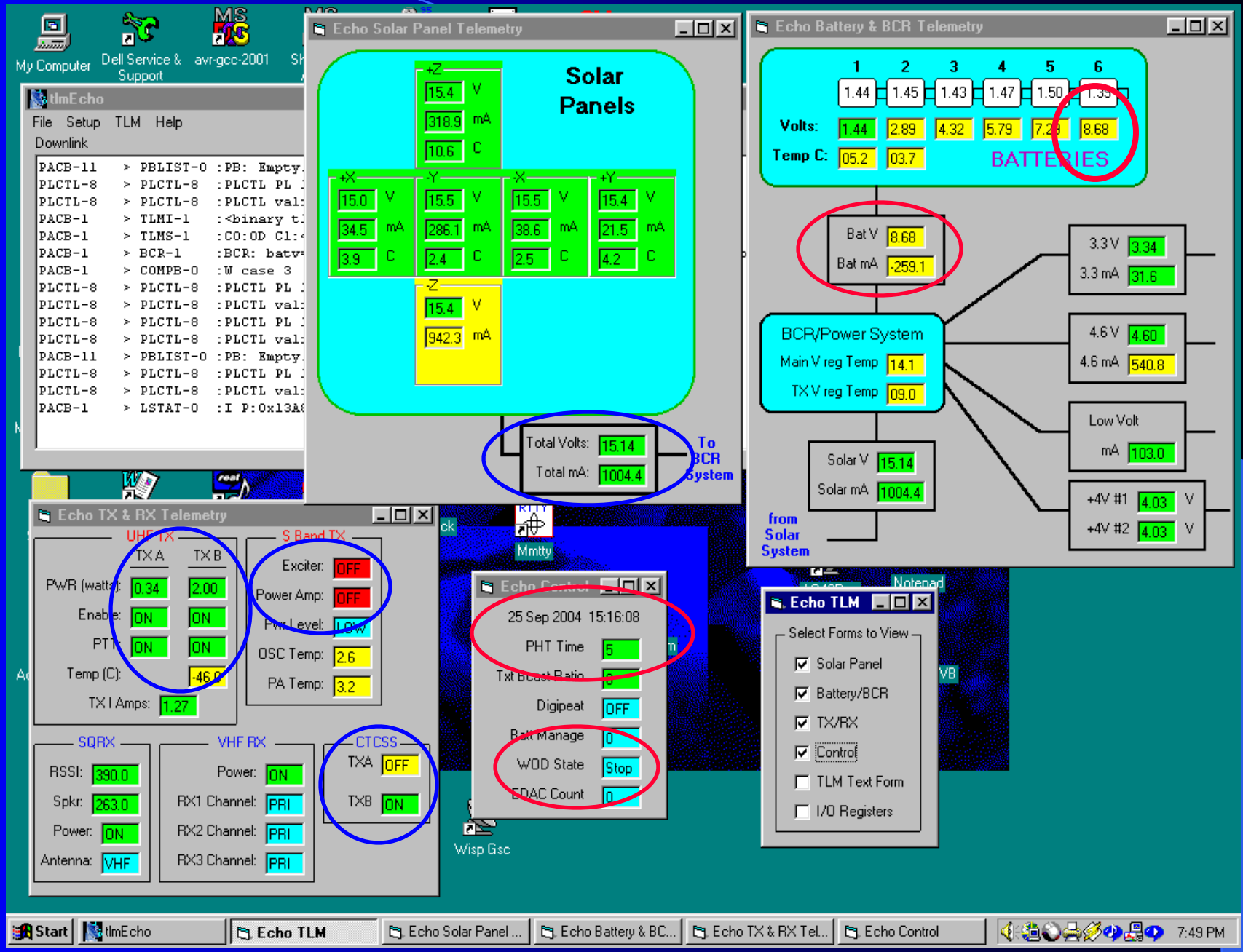
Echo Initialize and Loading

- Echo Starts at the BootLoader
- Load Kernal and PHTH (Initial Housekeeping Task)
  - From ROM onboard Echo
  - Uploaded from the Ground
- Load QAX25
- Load PHTX (Full Housekeeping Task)
- Load File System, 2 Separate Programs
- Load RX Control Program
- Load PL Control Program

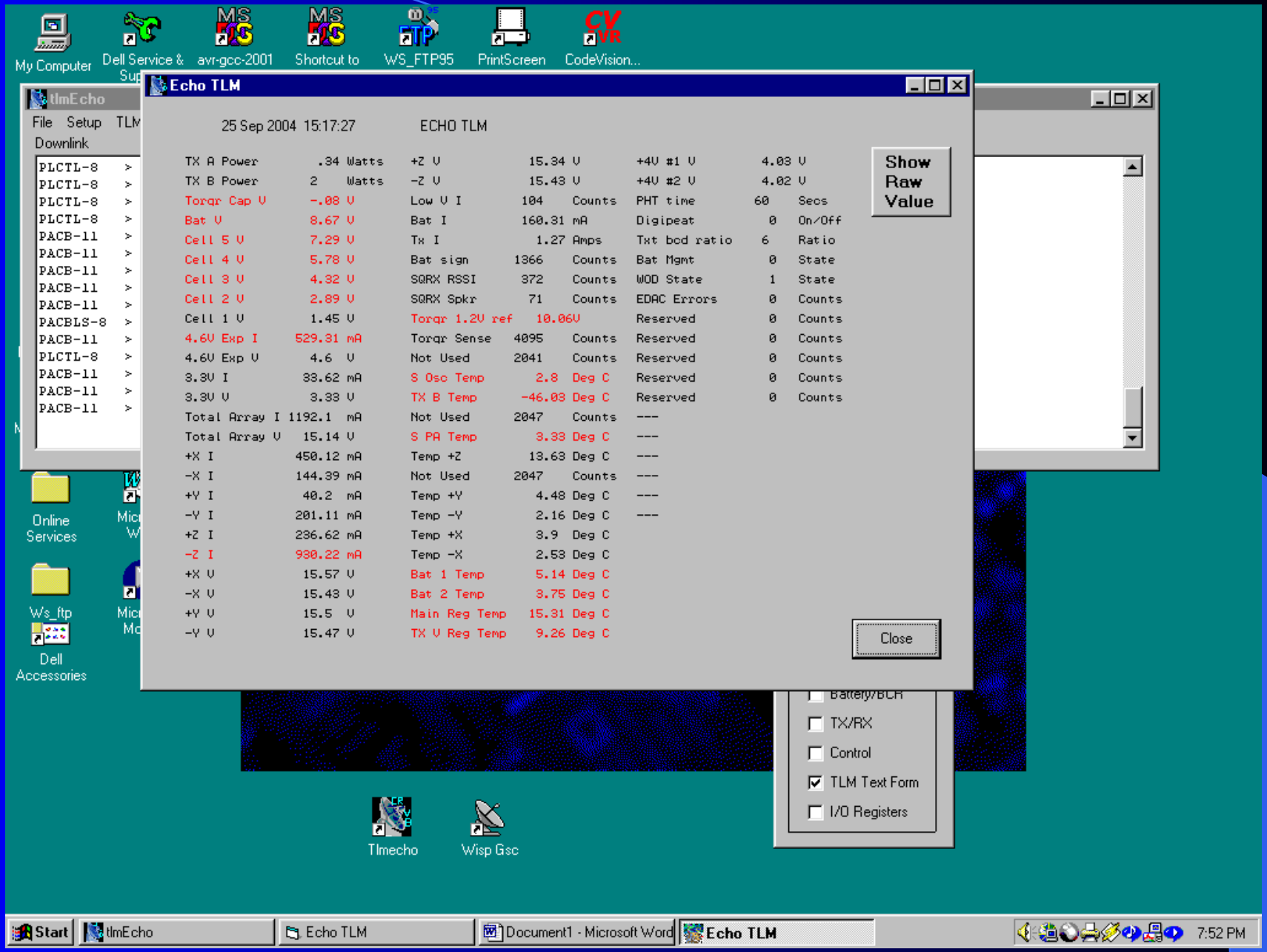
Echo Telemetry and WOD

- Telemetry Sent on the Digital Downlink, 435.150 mhz
  Rate varies by Command, PHT Time on TLM Screen
  Collected in CSV File Format by TlmEcho Program
- Whole Orbit Data (WOD) Collected in File System
  Collected at PHT Time Rate, Start/Stop by Command
  Stored in File System and Downloaded with WISP
  ReFormatted into CSV Format by WodEcho Program
- CSV Files are Viewed, Edited, and Graphed with Excel

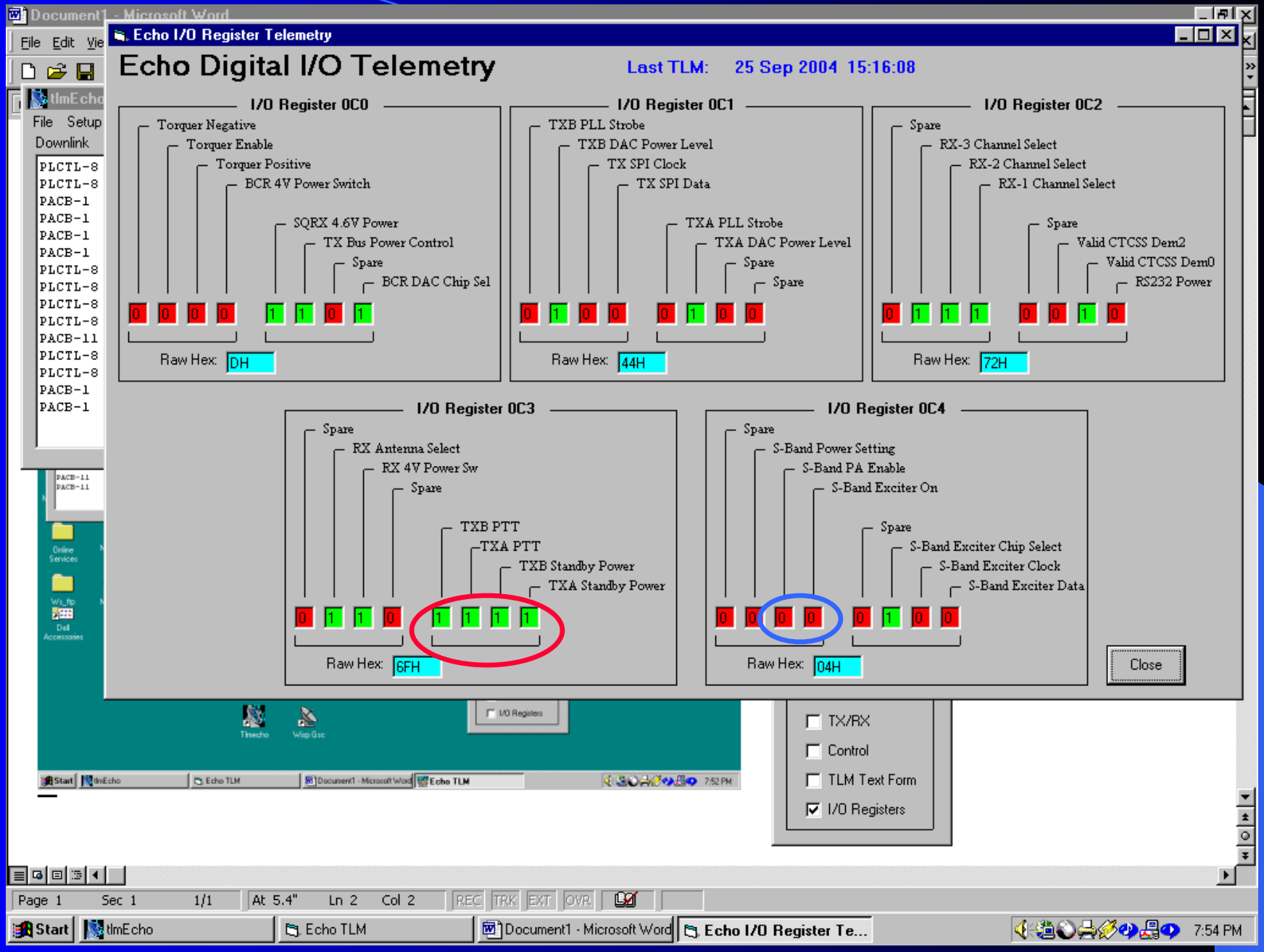
TlmEcho, Grouped Views



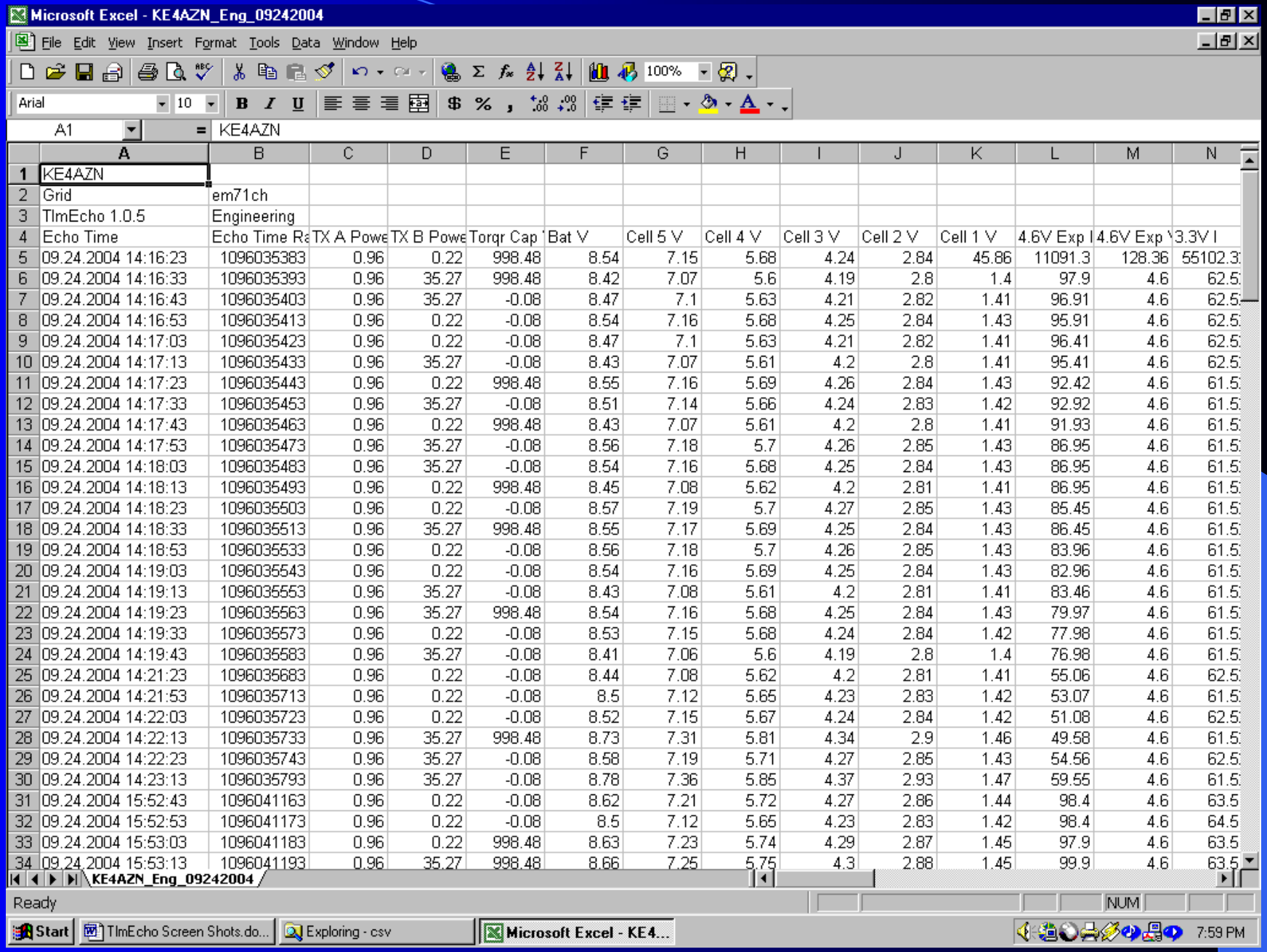
TlmEcho, Analog Text View



TlmEcho, Digital I/O View



Data in CSV Format

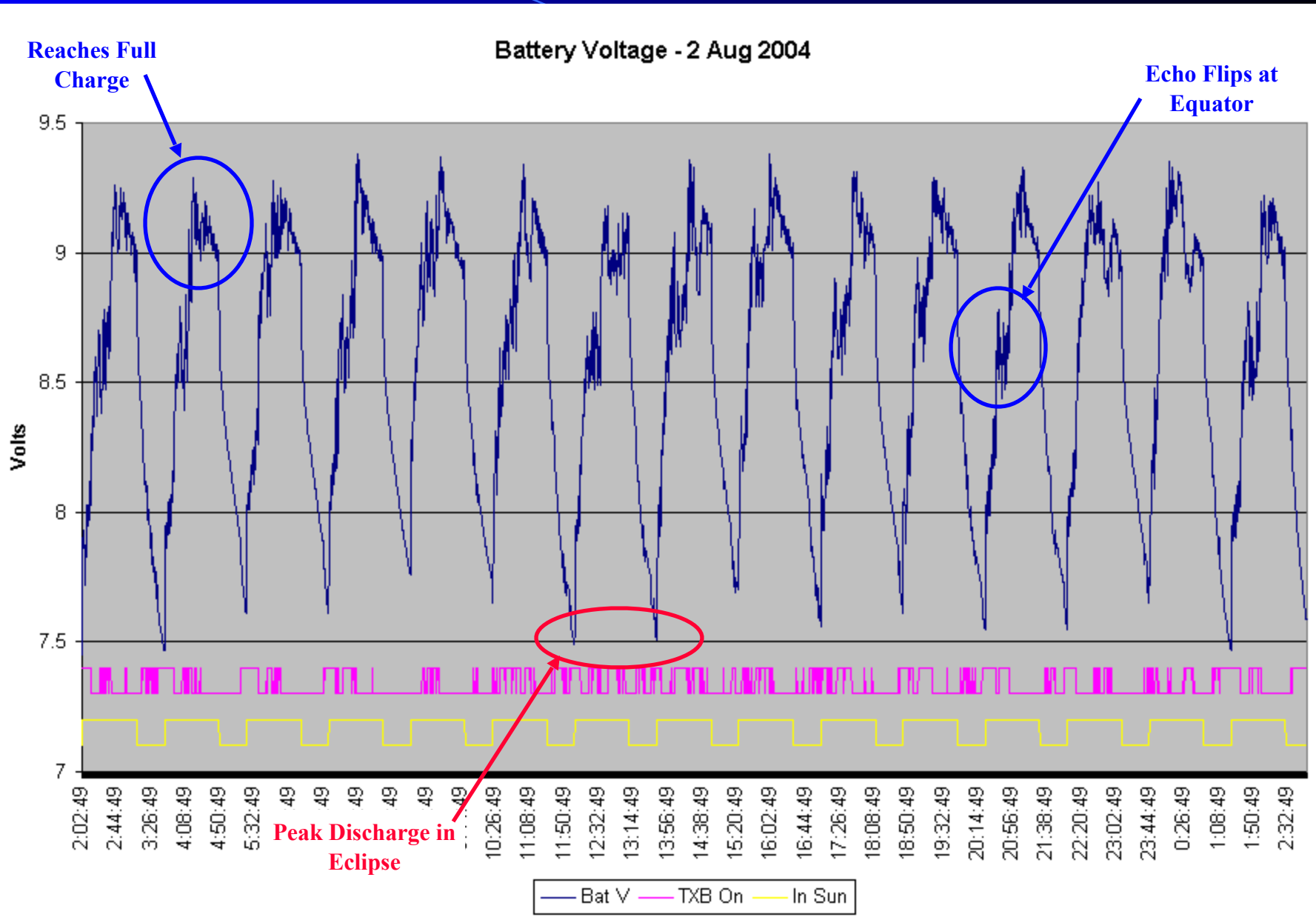


	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	KE4AZN													
2	Grid	em71ch												
3	TlmEcho 1.0.5	Engineering												
4	Echo Time	Echo Time Ra	TX A Powe	TX B Powe	Torqr Cap '	Bat V	Cell 5 V	Cell 4 V	Cell 3 V	Cell 2 V	Cell 1 V	4.6V Exp I	4.6V Exp '	3.3V I
5	09.24.2004 14:16:23	1096035383	0.96	0.22	998.48	8.54	7.15	5.68	4.24	2.84	45.86	11091.3	128.36	55102.3
6	09.24.2004 14:16:33	1096035393	0.96	35.27	998.48	8.42	7.07	5.6	4.19	2.8	1.4	97.9	4.6	62.5
7	09.24.2004 14:16:43	1096035403	0.96	35.27	-0.08	8.47	7.1	5.63	4.21	2.82	1.41	96.91	4.6	62.5
8	09.24.2004 14:16:53	1096035413	0.96	0.22	-0.08	8.54	7.16	5.68	4.25	2.84	1.43	95.91	4.6	62.5
9	09.24.2004 14:17:03	1096035423	0.96	0.22	-0.08	8.47	7.1	5.63	4.21	2.82	1.41	96.41	4.6	62.5
10	09.24.2004 14:17:13	1096035433	0.96	35.27	-0.08	8.43	7.07	5.61	4.2	2.8	1.41	95.41	4.6	62.5
11	09.24.2004 14:17:23	1096035443	0.96	0.22	998.48	8.55	7.16	5.69	4.26	2.84	1.43	92.42	4.6	61.5
12	09.24.2004 14:17:33	1096035453	0.96	35.27	-0.08	8.51	7.14	5.66	4.24	2.83	1.42	92.92	4.6	61.5
13	09.24.2004 14:17:43	1096035463	0.96	0.22	998.48	8.43	7.07	5.61	4.2	2.8	1.41	91.93	4.6	61.5
14	09.24.2004 14:17:53	1096035473	0.96	35.27	-0.08	8.56	7.18	5.7	4.26	2.85	1.43	86.95	4.6	61.5
15	09.24.2004 14:18:03	1096035483	0.96	35.27	-0.08	8.54	7.16	5.68	4.25	2.84	1.43	86.95	4.6	61.5
16	09.24.2004 14:18:13	1096035493	0.96	0.22	998.48	8.45	7.08	5.62	4.2	2.81	1.41	86.95	4.6	61.5
17	09.24.2004 14:18:23	1096035503	0.96	0.22	-0.08	8.57	7.19	5.7	4.27	2.85	1.43	85.45	4.6	61.5
18	09.24.2004 14:18:33	1096035513	0.96	35.27	998.48	8.55	7.17	5.69	4.25	2.84	1.43	86.45	4.6	61.5
19	09.24.2004 14:18:53	1096035533	0.96	0.22	-0.08	8.56	7.18	5.7	4.26	2.85	1.43	83.96	4.6	61.5
20	09.24.2004 14:19:03	1096035543	0.96	0.22	-0.08	8.54	7.16	5.69	4.25	2.84	1.43	82.96	4.6	61.5
21	09.24.2004 14:19:13	1096035553	0.96	35.27	-0.08	8.43	7.08	5.61	4.2	2.81	1.41	83.46	4.6	61.5
22	09.24.2004 14:19:23	1096035563	0.96	35.27	998.48	8.54	7.16	5.68	4.25	2.84	1.43	79.97	4.6	61.5
23	09.24.2004 14:19:33	1096035573	0.96	0.22	-0.08	8.53	7.15	5.68	4.24	2.84	1.42	77.98	4.6	61.5
24	09.24.2004 14:19:43	1096035583	0.96	35.27	-0.08	8.41	7.06	5.6	4.19	2.8	1.4	76.98	4.6	61.5
25	09.24.2004 14:21:23	1096035683	0.96	0.22	-0.08	8.44	7.08	5.62	4.2	2.81	1.41	55.06	4.6	62.5
26	09.24.2004 14:21:53	1096035713	0.96	0.22	-0.08	8.5	7.12	5.65	4.23	2.83	1.42	53.07	4.6	61.5
27	09.24.2004 14:22:03	1096035723	0.96	0.22	-0.08	8.52	7.15	5.67	4.24	2.84	1.42	51.08	4.6	62.5
28	09.24.2004 14:22:13	1096035733	0.96	35.27	998.48	8.73	7.31	5.81	4.34	2.9	1.46	49.58	4.6	61.5
29	09.24.2004 14:22:23	1096035743	0.96	35.27	-0.08	8.58	7.19	5.71	4.27	2.85	1.43	54.56	4.6	62.5
30	09.24.2004 14:23:13	1096035793	0.96	35.27	-0.08	8.78	7.36	5.85	4.37	2.93	1.47	59.55	4.6	61.5
31	09.24.2004 15:52:43	1096041163	0.96	0.22	-0.08	8.62	7.21	5.72	4.27	2.86	1.44	98.4	4.6	63.5
32	09.24.2004 15:52:53	1096041173	0.96	0.22	-0.08	8.5	7.12	5.65	4.23	2.83	1.42	98.4	4.6	64.5
33	09.24.2004 15:53:03	1096041183	0.96	0.22	998.48	8.63	7.23	5.74	4.29	2.87	1.45	97.9	4.6	63.5
34	09.24.2004 15:53:13	1096041193	0.96	35.27	998.48	8.66	7.25	5.75	4.3	2.88	1.45	99.9	4.6	63.5

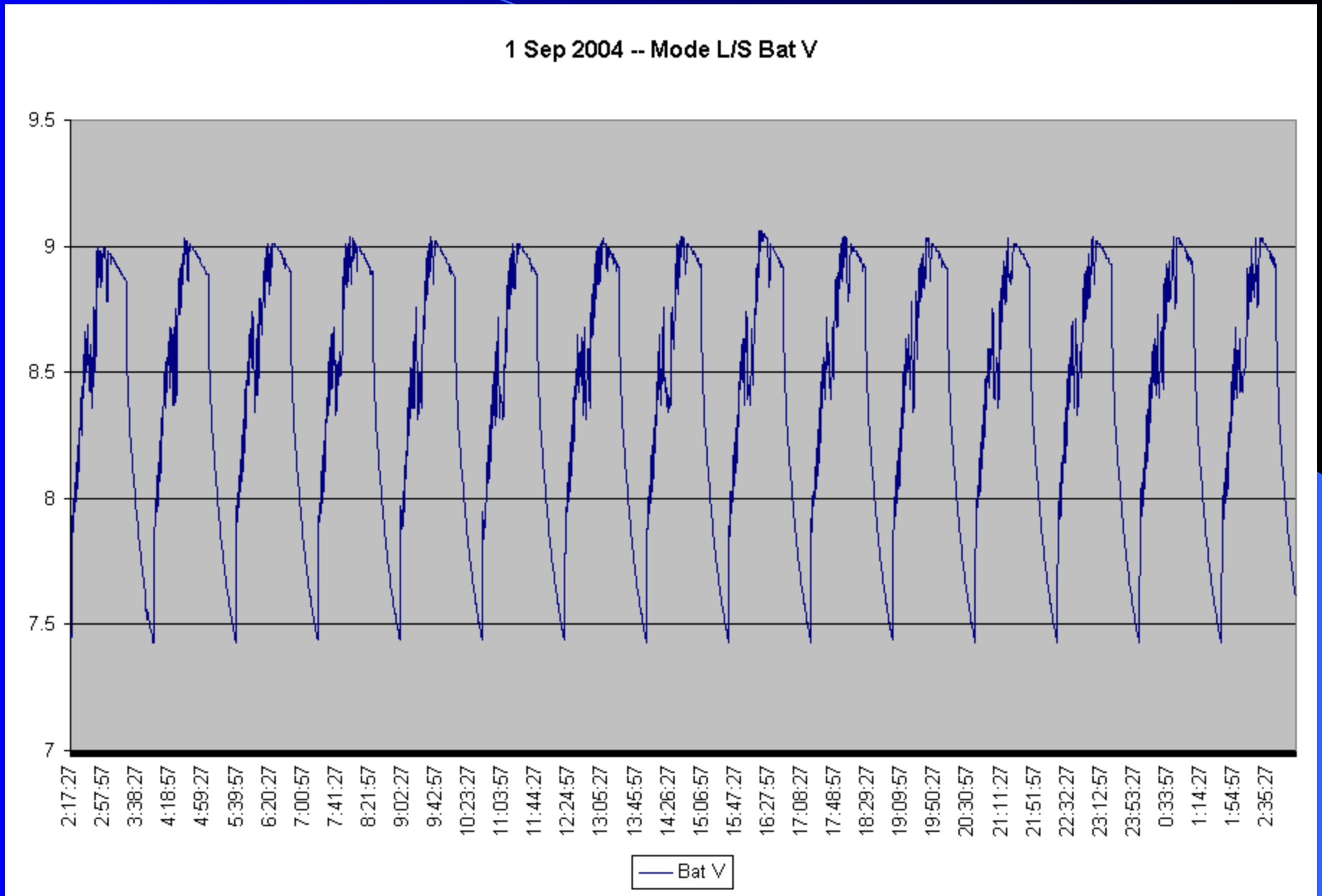
Echo Battery Monitoring

- Continuously Monitor Echo's Battery Status
  - Check with Live Telemetry
  - Check with WOD collections at various times
- Watch carefully with new Modes or Configurations
- Insure longest possible life of the Battery Pack
  - Deeper Eclipse Discharge = Shorter Satellite Life
  - Make sure Battery fully recovers before next Eclipse

Battery Voltage under “Normal” Configuration



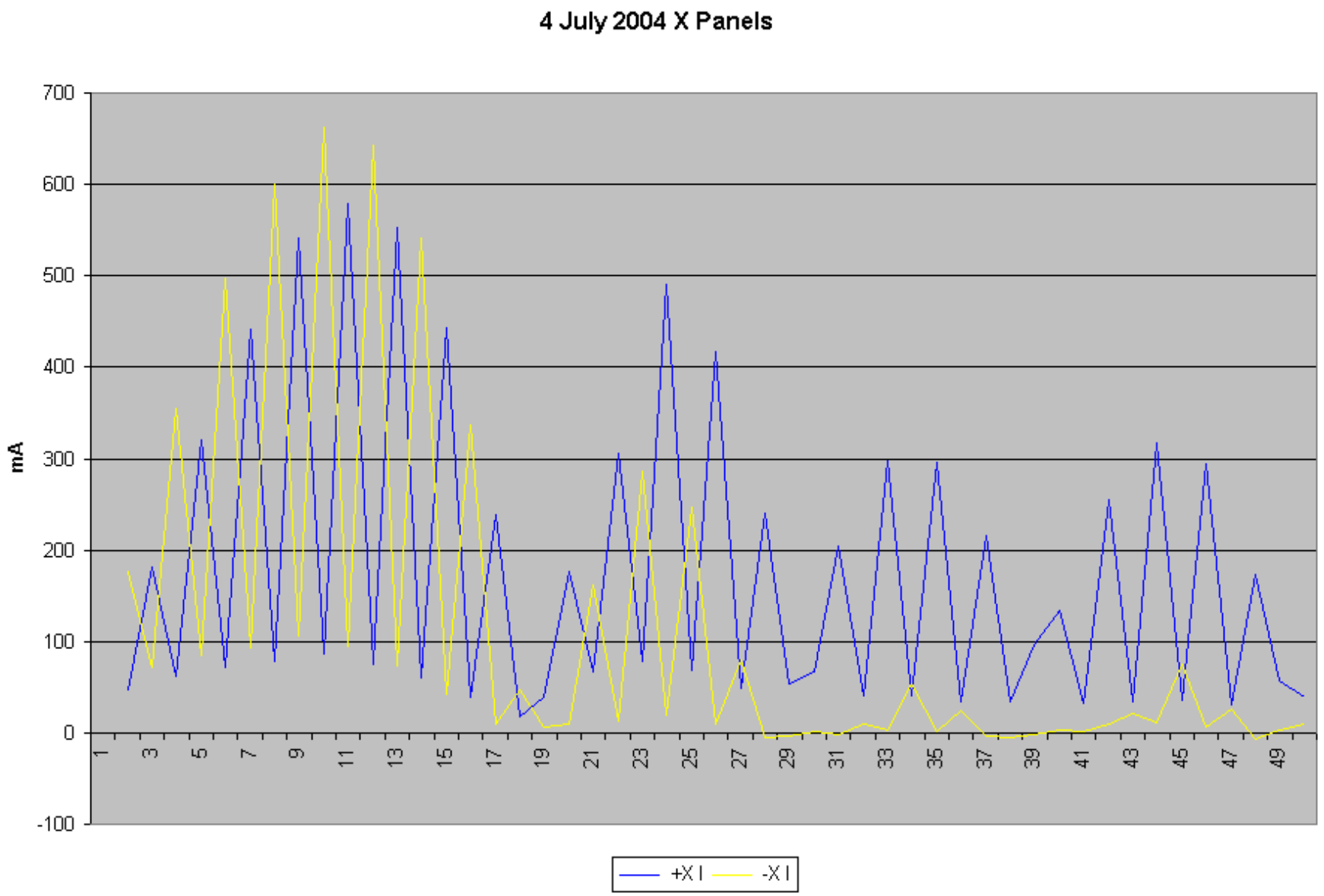
Battery V during L/S FM Mode



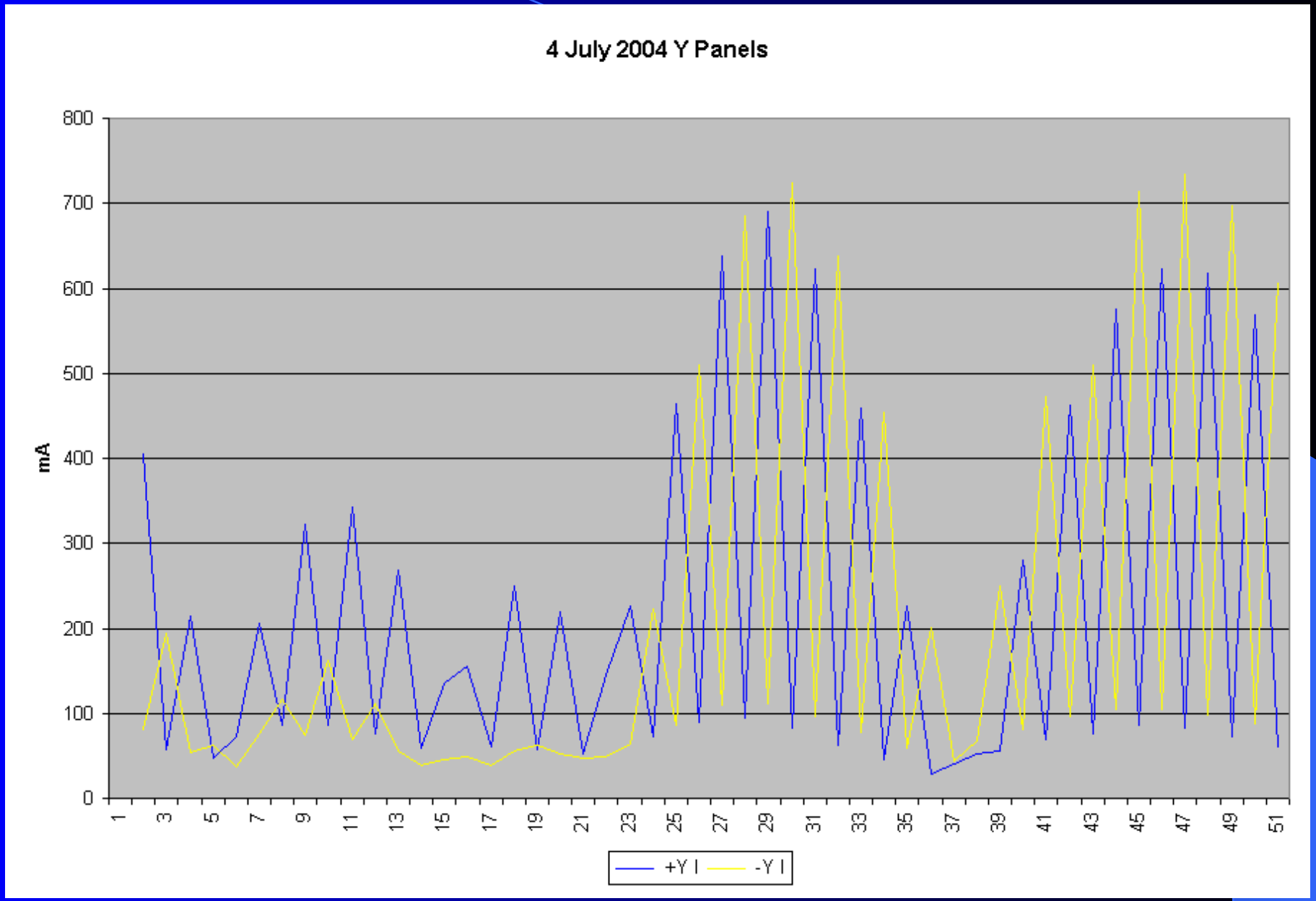
Echo Attitude Checks

- First Check, 4 July 2004
  - Echo Spinning at a high rate, faster than expected
  - Echo Wobbling
- Last Check, 5 Sept 2004
  - Spin has slowed to 32 sec / rev (1.87 rpm)
  - Wobble has dampened out, but not completely
- To Check Echo's Attitude
  - Use WOD collection for 1 Orbit, at 5 second intervals
  - Plot the Current Telemetry channel of each Solar Panel

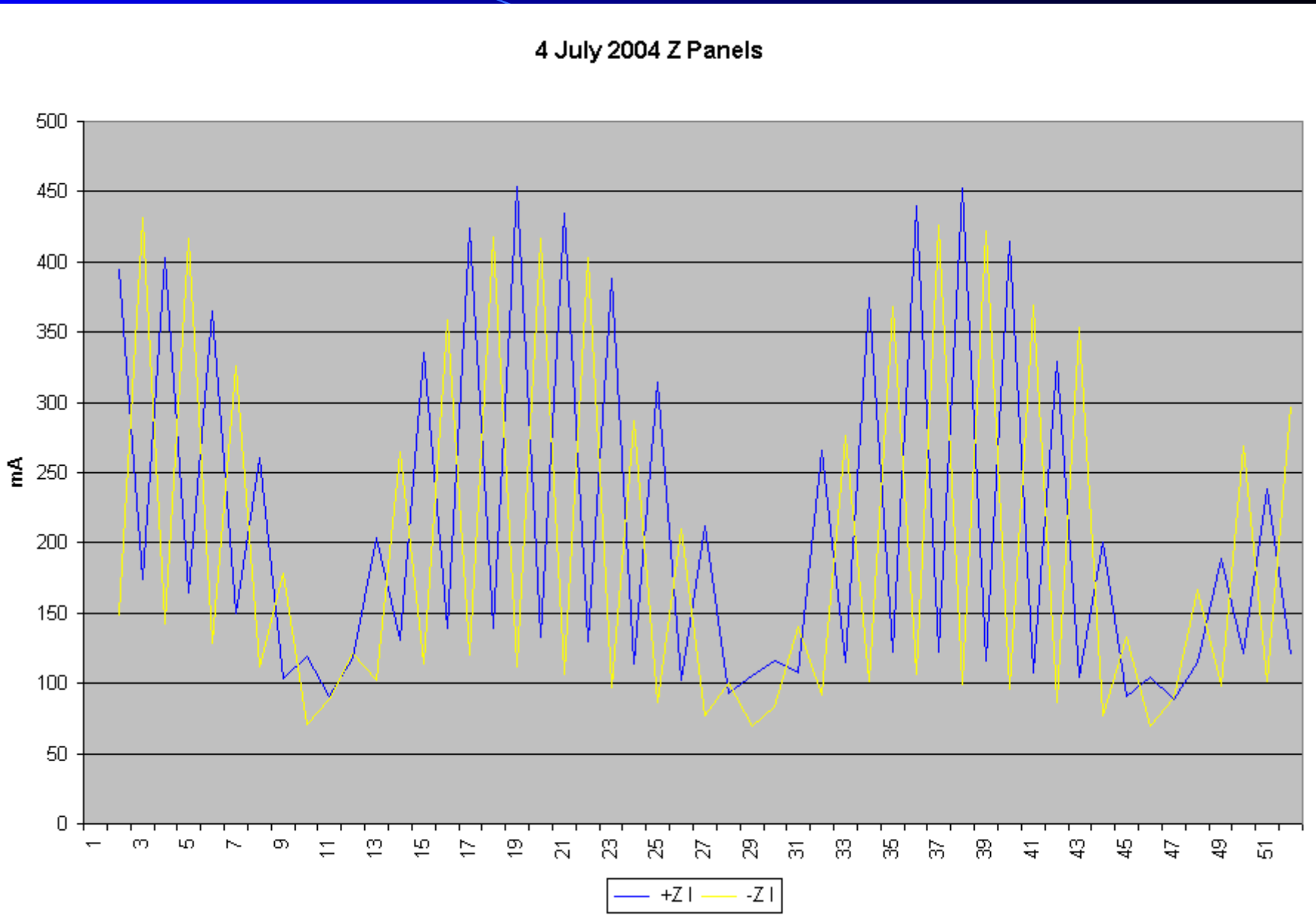
Attitude 4 July, X Axis



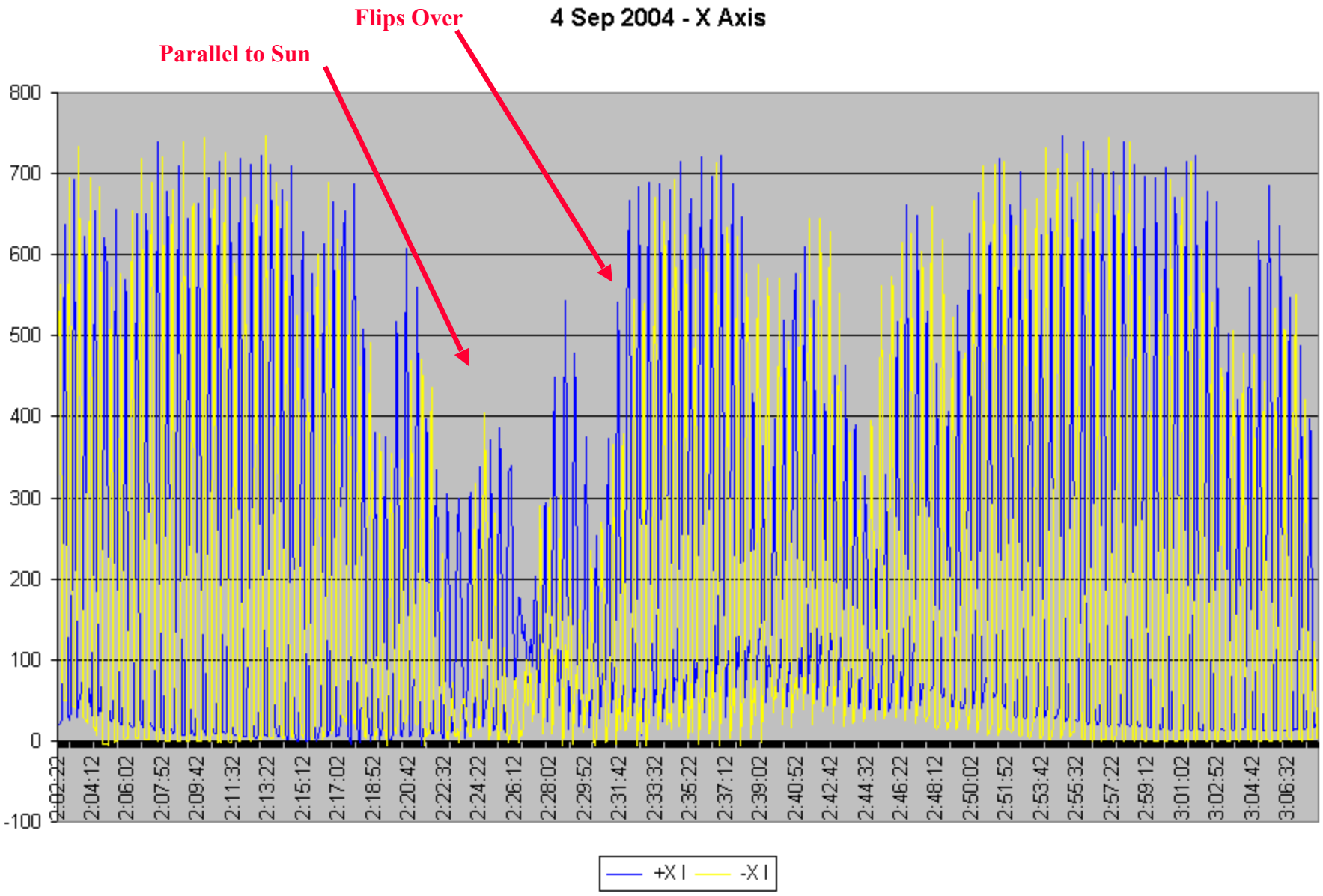
Attitude 4 July, Y Axis



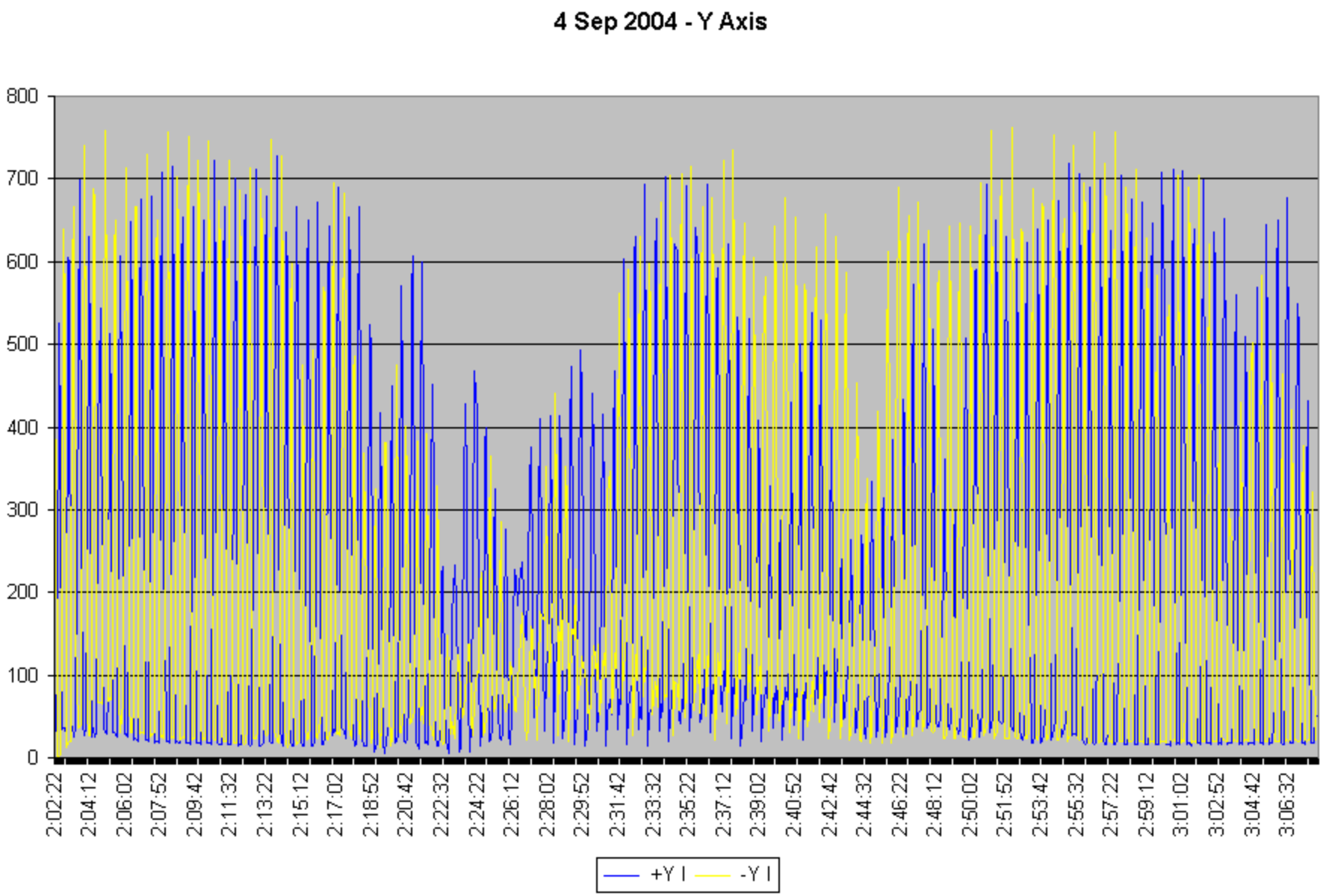
Attitude 4 July, Z Axis



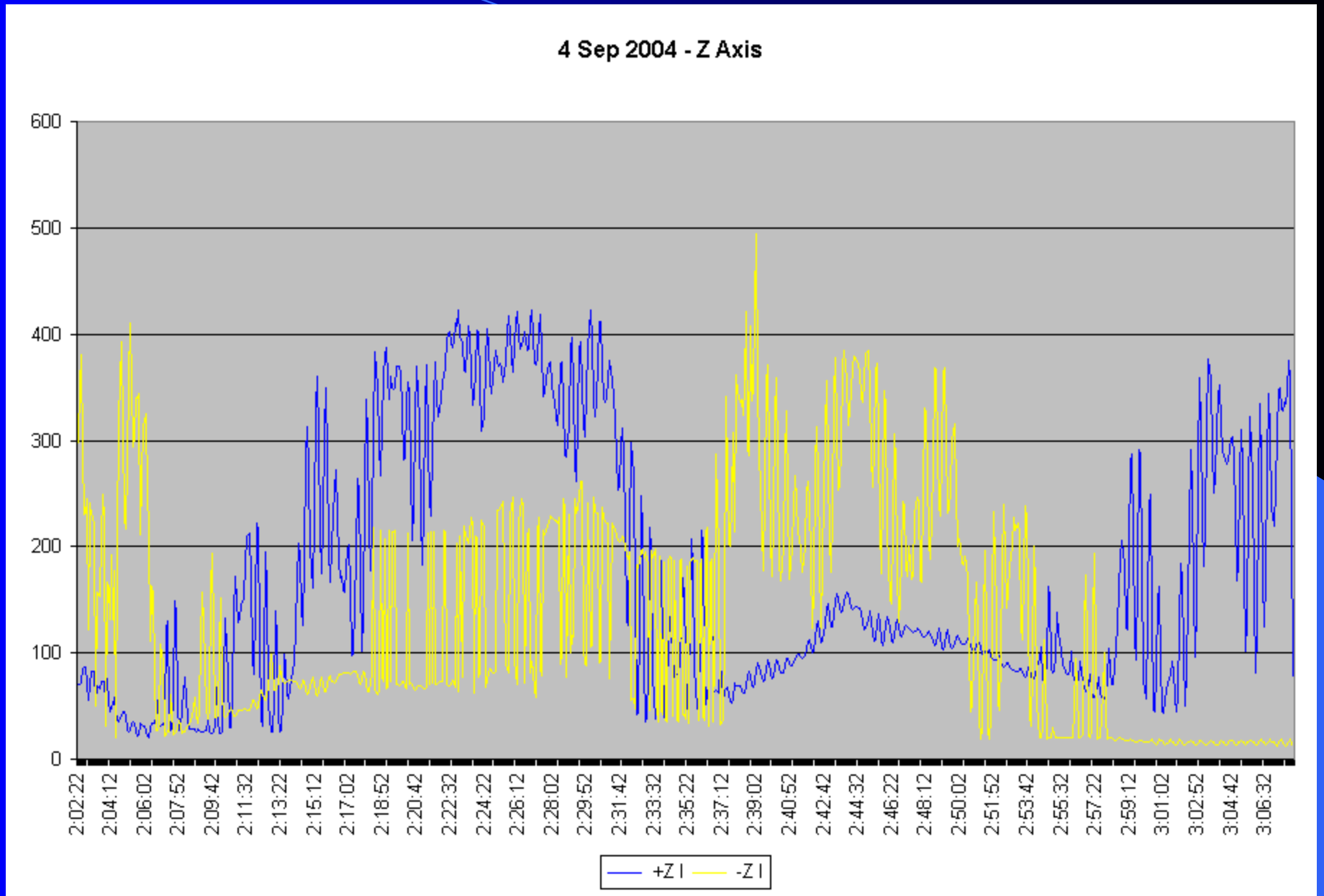
Attitude 4 Sept, X Axis



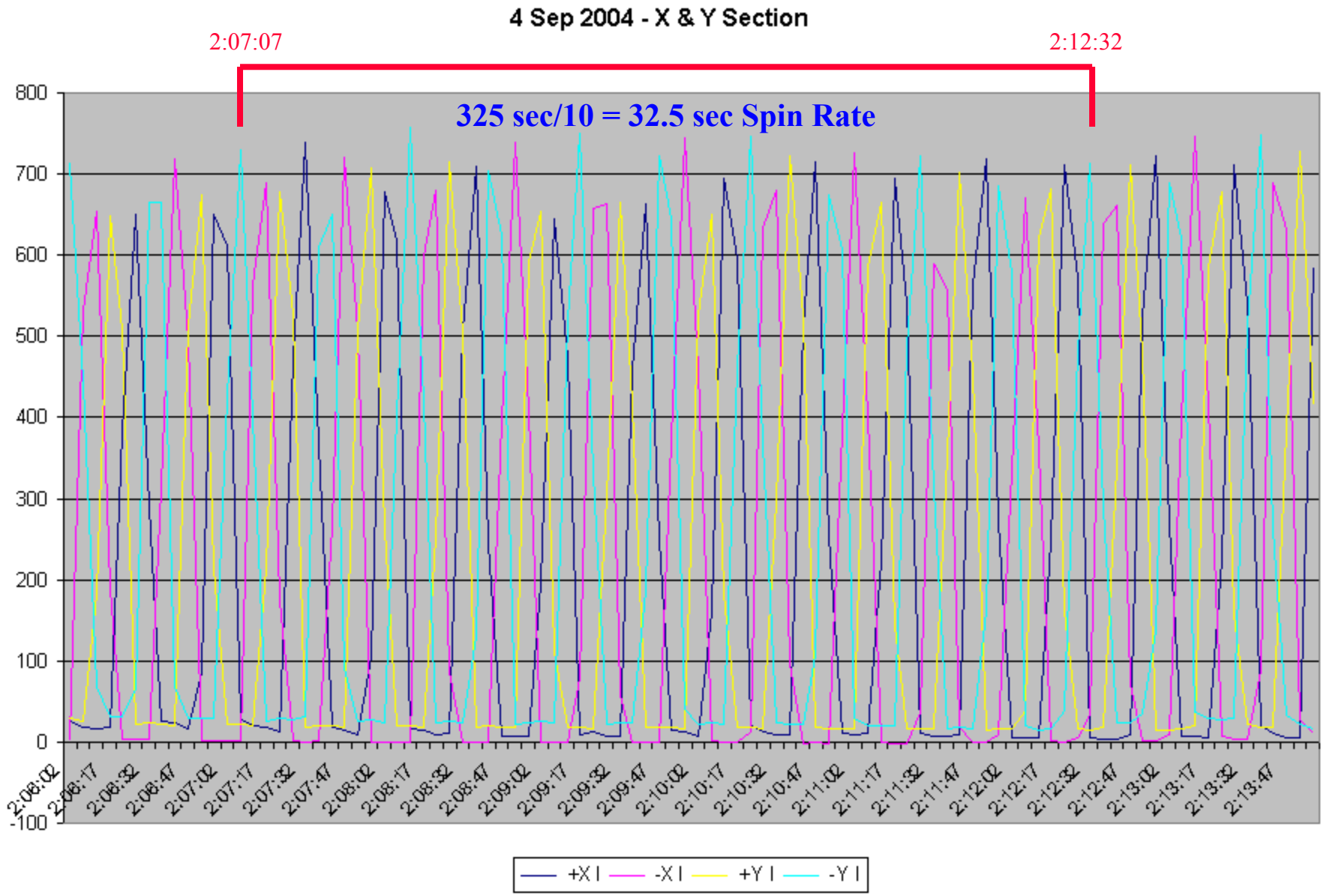
Attitude 4 Sept, Y Axis



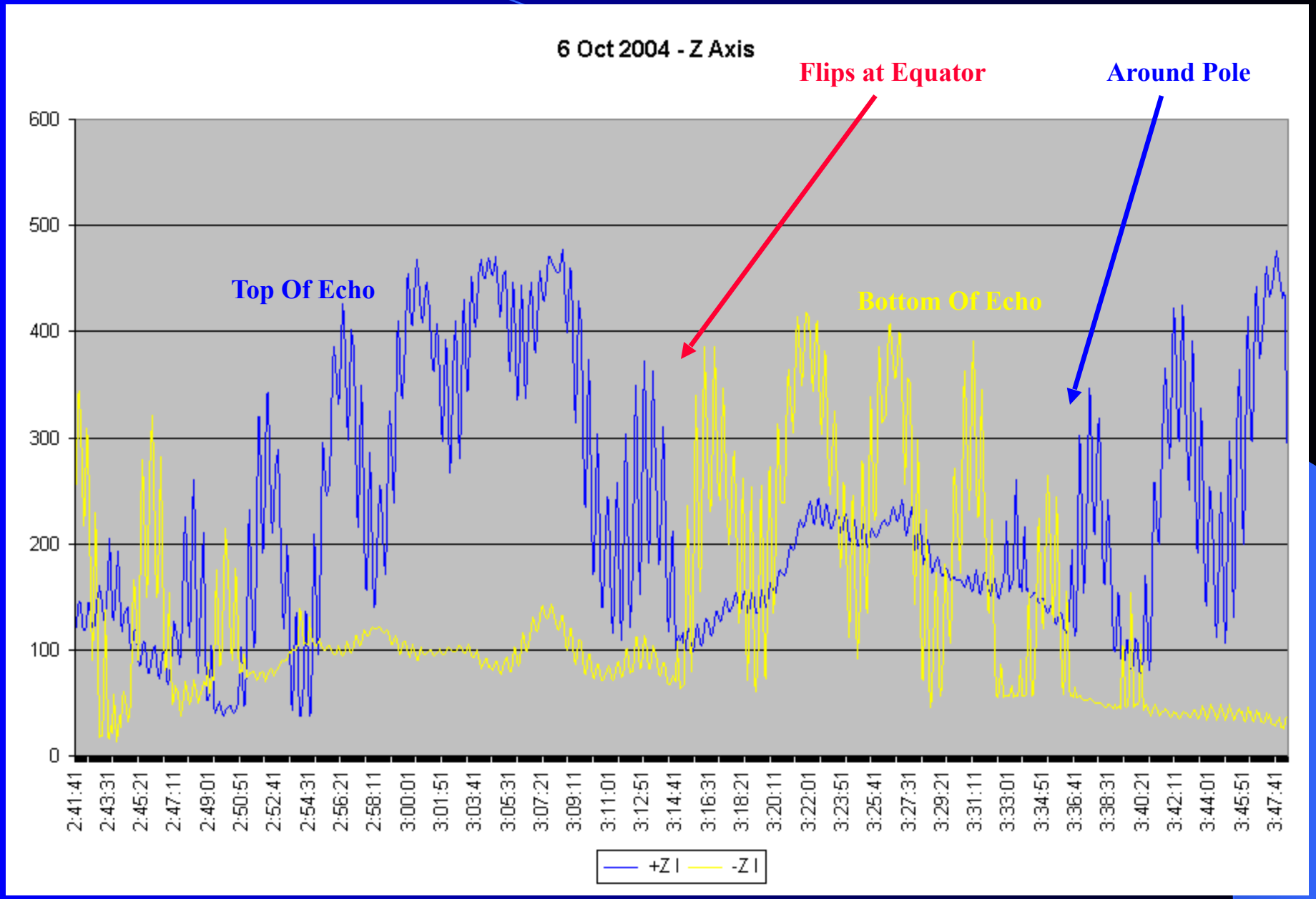
Attitude 4 Sept, Z Axis



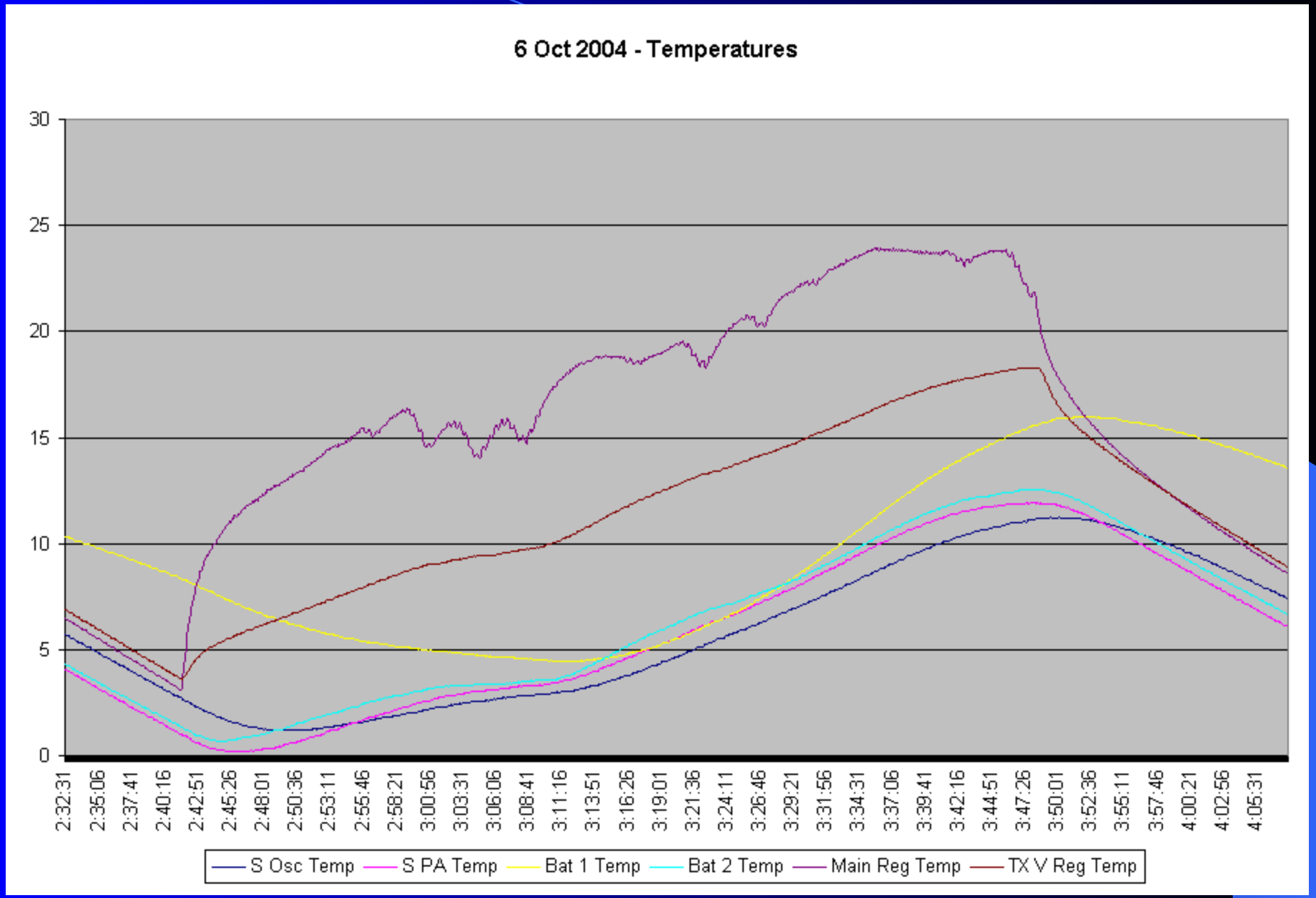
Attitude 4 Sept, Spin Rate



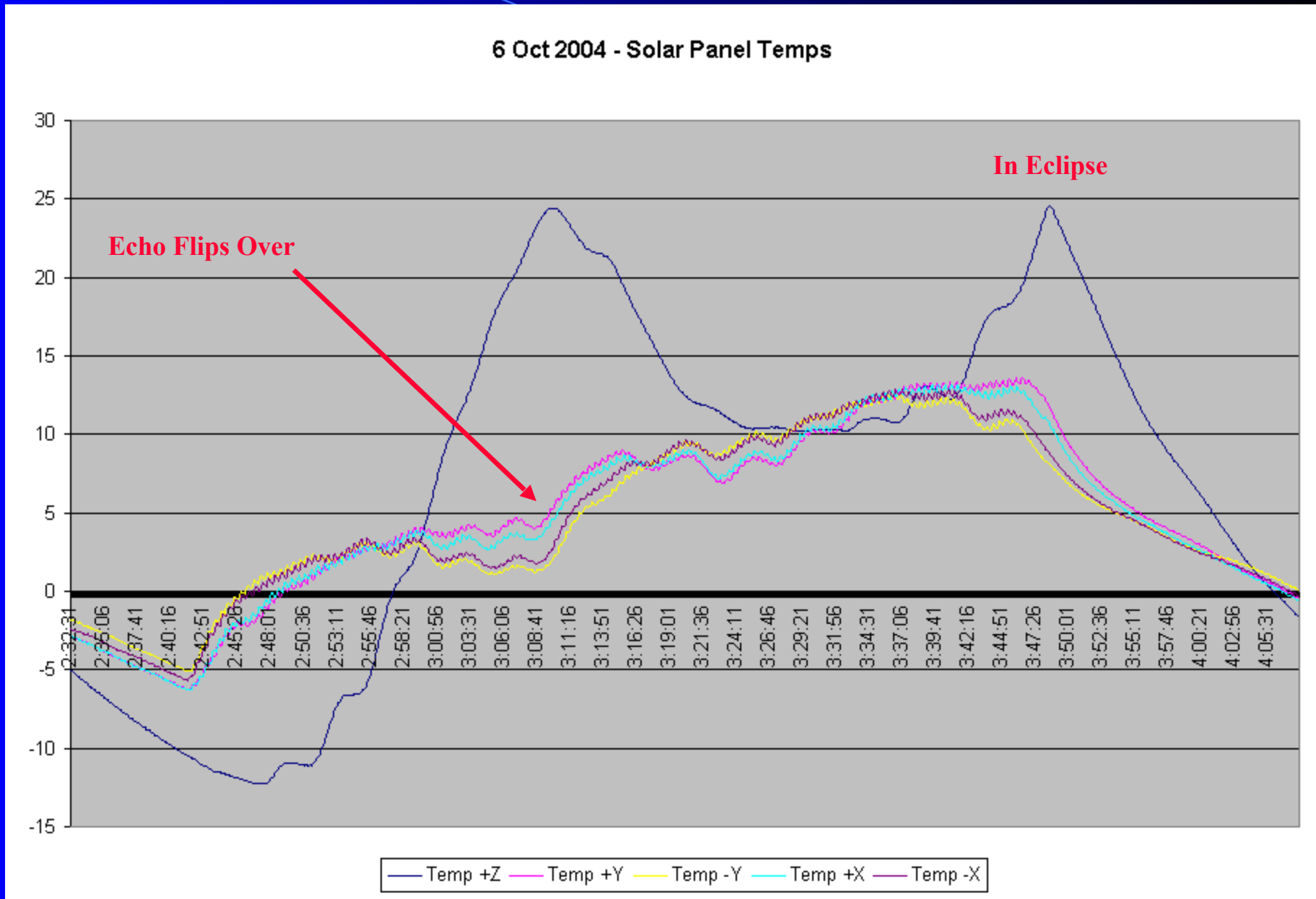
Attitude 6 October, Z Axis



Echo Temperatures



Echo Solar Panel Temperatures



Echo System Status, RX

- VHF Dedicated Receivers
  - All tested and are working well
  - RX3 (145.920) used as the FM Repeater Input
  - New Software needed to allow RX1-3 as Digital Uplink
- SQRX
  - Used as the Digital Uplink for BBS Ops on 145.860
  - Used on 1268.700 for L band Uplink
  - Used on 28.140 during PSK31 Tests
  - Antenna Relay switching between VHF and L Antennas

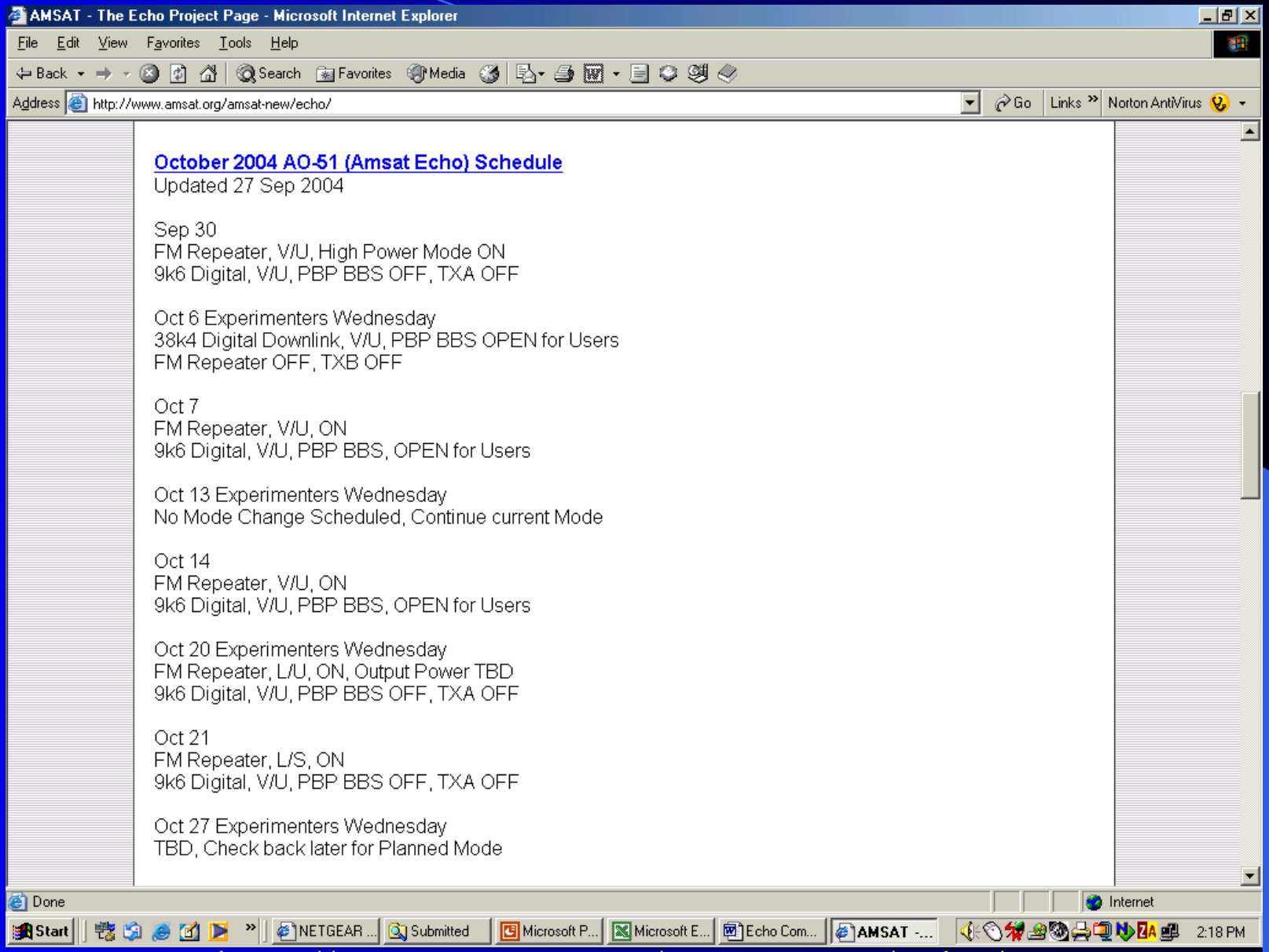
Echo System Status, TX

- UHF Transmitters working Well
  - TXA (435.150) has been used as the Digital Link
  - TXB (435.300) used as the FM Repeater Link
  - TXB Frequency changed to avoid interference with GO-32
  - UHF used in FM repeat, 9k6 digital, and 38k4 digital
- S Band Transmitter
  - Internal Temperatures are Good
  - Power Consumption is acceptable for continuous use
  - Used in FM repeat and 38k4 digital (cannot deviate 9k6)

Echo Modes

- FM Repeater, V/U, L/U, L/S
- 38k4 Digital Downlink, UHF and S Band
  - Works well with 1 watt output on UHF
  - S Band Test inconclusive, more testing planned
- PSK31, 10 meters USB/U FM
  - Last Orbit of the last session improved TX Settings
  - More Test Sessions Planned
  - Experimental Mode, Echo not Designed for 10 meter RX

Echo Scheduling, available at AMSAT.ORG

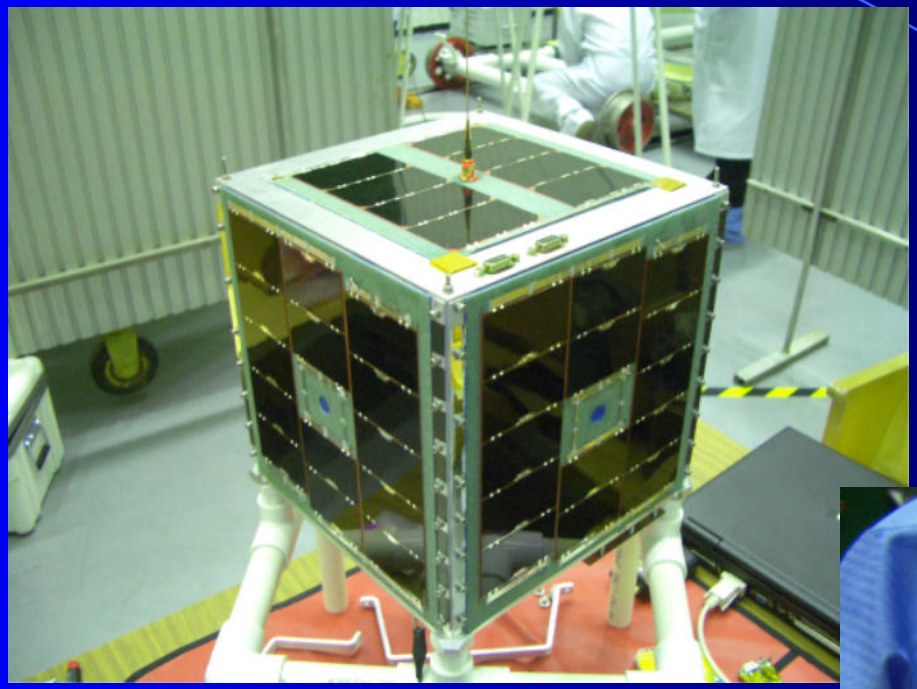

AMSAT - The Echo Project Page - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://www.amsat.org/amsat-new/echo/
Go Links Norton AntiVirus
October 2004 AO-51 (Amsat Echo) Schedule
Updated 27 Sep 2004
Sep 30
FM Repeater, V/U, High Power Mode ON
9k6 Digital, V/U, PBP BBS OFF, TXA OFF
Oct 6 Experimenters Wednesday
38k4 Digital Downlink, V/U, PBP BBS OPEN for Users
FM Repeater OFF, TXB OFF
Oct 7
FM Repeater, V/U, ON
9k6 Digital, V/U, PBP BBS, OPEN for Users
Oct 13 Experimenters Wednesday
No Mode Change Scheduled, Continue current Mode
Oct 14
FM Repeater, V/U, ON
9k6 Digital, V/U, PBP BBS, OPEN for Users
Oct 20 Experimenters Wednesday
FM Repeater, L/U, ON, Output Power TBD
9k6 Digital, V/U, PBP BBS OFF, TXA OFF
Oct 21
FM Repeater, L/S, ON
9k6 Digital, V/U, PBP BBS OFF, TXA OFF
Oct 27 Experimenters Wednesday
TBD, Check back later for Planned Mode
Done
Internet
Start
NETGEAR ...
Submitted
Microsoft P...
Microsoft E...
Echo Com...
AMSAT -...
2:18 PM

http://www.amsat.org/amsat-new/echo/

Future Plans and Tests

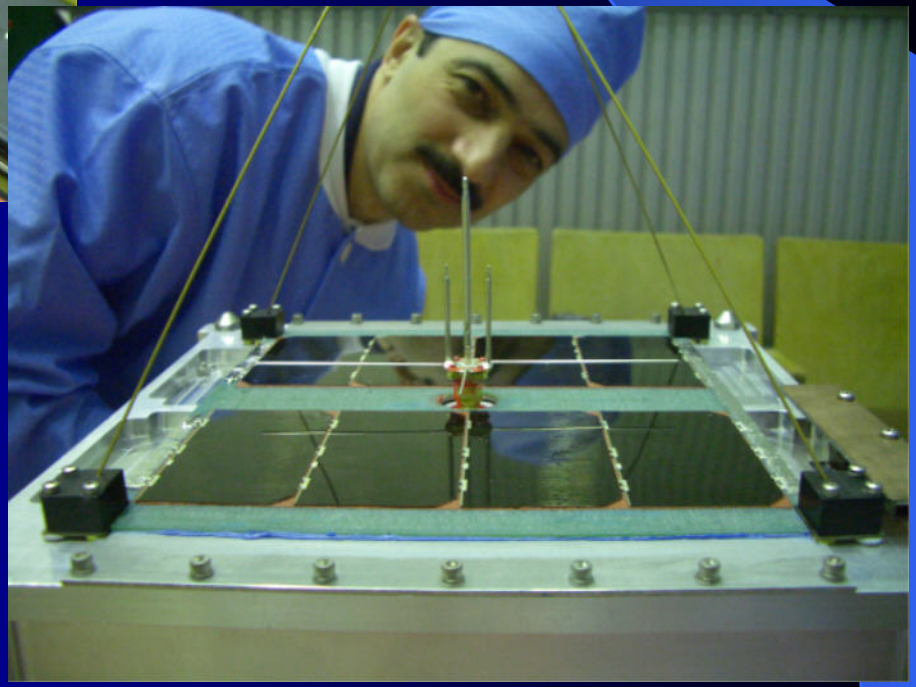
- L Digital Uplink
- S Band TX at 38k4 Digital
- PSK31 Experimental Mode
- Dual FM Repeaters (V/U)
- Software Upgrade
  - Improved WOD Data Collection
  - Output Power Control and PL Function
  - Mode Switching and Scheduling
- Test the Adjustable Torque Rod System
- Higher Speed Digital as Hardware becomes available

Just the Beginning



What is Echo to You?

Pictures Courtesy of Chuck Green, N0ADI



It is what YOU make of it!

Utilize it, Promote it,

Enjoy It